

Original Research Article

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## Assessment of Microbial Contamination of Paper Currency Notes in Circulation

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### ABSTRACT

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Money, whether in the form of coins or paper notes is perhaps the most widely handled article by people everyday throughout the world. Money is used as a medium for exchange for goods and services, settlement of debts and for deferred payments in economic activities. Currency notes represent a universal medium for the transmission of bacteria in the environment and among humans. There is a possibility that currency notes might act as environmental vehicles for the transmission of pathogenic organisms. This prospective study, which was carried out for a period of two months in a tertiary care hospital. The present investigation was carried out on one hundred and twenty Indian paper currency notes of all the denominations obtained from different occupational groups in Tirunelveli City, TamilNadu, India. 86.4 % of currencies were contaminated with pathogenic organisms. 121 isolates from the collected Indian paper currency yielded 6 different types of bacterial species. Assessment revealed active participation of the following organisms as *Escherichia coli*, *Bacillus* spp, *Klebsiella* spp, *Staphylococcus aureus*, *Micrococci* and *Pseudomonas* spp. Rs.100, Rs.50 had more contamination, other denominations like Rs.5, Rs.10, Rs.20 had moderate contamination and less contamination with Rs.500 and Rs.1000.. The study suggested that Indian paper currency notes are highly contaminated with pathogenic microorganisms and this contamination may play a significant role in transmission of infectious diseases. Hence, great care must be taken while handling money during the preparation and handling of food to avoid cross contamination.

### Introduction

Globally, money is one of the items most frequently passed from hand to hand. During its passing, money can get contaminated and may thus play a role in the transmission of microorganisms to other people.

For example, money may get contaminated with microorganisms from the respiratory and gastro-intestinal tract during counting.

Money is not usually suitable for the survival of microorganisms, except for some that are resistant to external conditions and non-resistant forms of spores.[1,2]In addition, the general hygiene levels of a community or society may contribute to the amount of microbes found on coins and notes, and thus the chance of transmission during handling of money.

Indian paper currency is commonly contaminated with pathogenic bacteria and this contamination may play a significant role in the transmission of different diseases. People and government are relevant about spread of pathogens through food, air, water and have taken enough steps to control it. But, they are not aware about the possibility of acquiring infection while applying saliva on fingers for counting currency notes which are widely exchanged from hand to hand represents a universal medium for transmission of microbes in the environment and among humans.

Antimicrobial resistance is a global phenomenon that has resulted in high morbidity and mortality as a result of treatment failures and increased health care costs.[3] While antimicrobial resistance has steadily been increasing, e.g. with Extended-Spectrum Beta Lactamases (ESBL) producing *Escherichia coli* and *Klebsiella spp* contaminated banknotes and coins contribute to the transmission of these multi-drug resistant microorganisms in the community.[4]

In India, few studies have reported the microbial colonization of currency. Studies of the contamination of money with microbial agents is lacking in Southern Tamil Nadu. Knowledge of the microbial diversity of currency notes in circulation can provide the basis for raise health consciousness in people during currency handling and effective control of infection transmission. Hence, the present study was undertaken to identify microbial contamination of Indian currency notes in circulation and to study the antibiotic susceptibility pattern of the pathogenic isolates.

## **Materials and Methods**

### **Study Area and Design**

The study was conducted in different parts

of Tirunelveli, TamilNadu, India where various Indian currency denominations were randomly collected from everyday use from March 2014 to August 2014 and processing of samples were done at Microbiology Department, Tirunelveli Medical College Hospital. The study protocol was approved by the Institutional Scientific and Ethics Committee.

### **Sample Collection**

A total of 140 paper currency notes consisting of Twenty notes of each of INR.5, INR.10, INR.20, INR.50, INR.100, INR.500 and INR.1000 denominations were collected from Doctors, various shops of vegetable, fruit, spices selling and slaughter house aseptically. To collect the paper currency, the individual were requested to drop currency notes into a sterile polythene bag and labelled accordingly; notes were not touched by the researcher using bare hands at any stage. The packet was sealed and immediately transported to the laboratory for analysis.30 more new currency notes were collected from the bank as control samples.

### **Laboratory Methods and Procedures**

All laboratory works were undertaken in the Microbiology laboratory.

### **Identification and Isolation of Microbes**

Sterile cotton swab was dipped in the sterile distilled water and was rubbed on both the surfaces of currency notes and then to inoculate onto the culture plates for each note. The plates were incubated at 37°C for 24 hours. Then the plates were observed for bacterial colonies. Pure isolated colonies were Gram differentiated and then biochemically identified using Indole, Catalase, Citrate, Oxidase, Coagulase, and Urease tests.

### **Antibiotic Susceptibility Test (AST)**

Antibiotic susceptibility was determined by the agar diffusion technique on Mueller-Hinton agar (Kirby-Bauer NCCLS modified disc diffusion technique) using 9 antibiotic discs including Ampicillin (10µg), Amikacin (30µg), Gentamicin (10µg), Cotrimoxazole (25µg), Cefotaxime (30µg), Ceftazidime (30µg), Ceftriaxone (30µg), Ciprofloxacin(5µg) and Erythromycin (5µg).

### **Results and Discussion**

The paper currency notes are graded using condition, appearance and degree of dirtiness as new, moderate and old as shown in Table 1. The present study revealed the extent and the level of microbial contamination of Indian paper currency. 86.4 % of currencies were contaminated with pathogenic organisms. 121 isolates from the collected Indian paper currency yielded 6 different types of bacterial species. Identification showed the active participation of these species in descending order as, *Klebsiella* spp, *Bacillus* spp, *Escherichia coli*, *Pseudomonas* spp, *Micrococci* and *Staphylococcus aureus*. The frequency of occurrence of *Klebsiella* spp was the highest in the present study which indicates the presence of faecal contamination via cross-contamination with raw products or poor personal hygiene.

Table 2 shows the prevalence occurrence of pathogenic microorganisms isolated from Indian paper currency notes from different occupational groups mainly fish seller, meat

Seller, vegetable seller, Doctors. The results showed in Table 3 indicated that all the currency denominations groups had microbial contamination and Rs.100, Rs.50 had more contamination, other denominations like Rs.5, Rs.10, Rs.20 had moderate contamination and less

contamination with Rs.500 and Rs.1000. These lower denominations are used frequently for different normal daily activities. Higher denominations are not used as frequently as lower denominators. Smaller unit notes appeared to be more highly contaminated than larger unit notes, probably because the smaller unit notes are most frequently handled in petty, daily monetary transactions and are often tattered, dirty.

Resistance pattern of all pathogenic Gram negative bacilli and Gram positive organisms were given in Table 4. Only one isolate of *Staphylococcus aureus* was MRSA and All the Gram negative bacilli were resistant to Ampicillin. 11 strains of *E. coli* and 49 strains of *Klebsiella* were resistant to Ampicillin. These two bacteria were found to be quite sensitive to Amikacin, Gentamicin and Ciprofloxacin. *Klebsiella* were more resistant to different cephalosporin groups whereas *E.coli* was less resistant. *Pseudomonas* was quite sensitive to Amikacin, Gentamicin, Ciprofloxacin and cephalosporins.

The present study collected the notes from various sources such as fish seller, meat Seller, vegetable seller, Doctors, local markets and banks which are in accordance with the previous studies [5-8] 86.4 % of the notes analyzed were found to be contaminated with pathogenic organisms. Extent of contamination was found related to the denominations of the currency. Currency notes of lower denominations (Rs.5, Rs.10, 20, 50,100) were the most contaminated than higher denominations (Rs.500, Rs.1000) and this is consistent with previous studies.[5,9]This is expected, as lower denomination notes pass through more hands than the higher denomination during petty, daily monetary transactions and are often tattered, dirty.

The present study suggests that currency notes may carry enteric pathogens. This goes a long way to reveal the poor sanitary condition of the environment as well as poor personal hygiene practices observed by most of the occupational groups. Goktas and Oktay (1992) found similar result as present investigation. They isolated aerobic spore forming bacilli (91%), *Staphylococcus epidermidis* (63.3%), *Staphylococcus aureus*

(4.2%), *Enterococcus* (24.1%), alpha haemolytic *streptococcus* (4.1%), *Streptococcus pneumonia* (1.7%), *Corynebacterium* (7.5%), *Lactobacilli* (10.8%), *Klebsiella pneumoniae* (31.7%), *Enterobacter* (19.2%), *E. coli* (17.5%), *Proteus* (1.7%), *Pseudomonas aeruginosa* (0.8%), *Shigella flexneri* (0.8%) from paper money samples of one hundred twenty currency notes.[10]

**Table.1** Physical Condition of Indian Paper Currency Notes Collected From Different Occupational Groups

	OLD	MODERATE	NEW	TOTAL
INR 5	12	6	2	20
INR 10	5	8	7	20
INR 20	7	7	6	20
INR 50	7	9	4	20
INR 100	8	6	6	20
INR 500	5	7	8	20
INR 1000	3	8	9	20
TOTAL	47	51	42	140

**Table.2** Source of Microbial Isolates in Indian Currency Notes

	<i>E.coli spp</i>	<i>Kleb siella spp</i>	<i>Pseudo monas spp</i>	<i>Micro cocci spp</i>	<i>Staphylococc us spp</i>	<i>Bacillus spp</i>	No growth	Total
Doctors	2	4	1	0	0	1	3	11
Vegetable vendor	3	9	2	3	1	7	5	30
Fish vendor	2	4	0	0	0	1	1	8
Butchers	2	4	0	0	0	0	1	7
Banks	1	5	0	2	0	2	3	13
Bus conductor	0	7	2	1	0	3	7	20
Student	0	8	0	0	0	0	0	8
Hotel	2	2	0	1	0	2	0	7
Bike spares vendor	1	8	0	0	0	0	5	14
Lab technician	0	1	0	0	0	0	14	15
House wife	0	5	0	0	0	2	0	7
Total	13	57	5	7	1	18	39	140

**Table.3** Percentage of Bacterial Genus Isolated from Indian Currency Notes in Circulation

	<i>E.coli spp</i>	<i>Klebsella Spp</i>	<i>Pseudomonas Spp</i>	<i>Micrococci Spp</i>	<i>Staphylococcus Spp</i>	<i>Bacillus Spp</i>	No Growth	Total
INR 5	1 (7%)	4 (7%)	1 (20%)	0 (0%)	0 (0%)	6 (33.3%)	8 (20.5%)	20
INR 10	1 (7%)	10 (17.5%)	2 (40%)	0 (0%)	1 (100%)	0 (0%)	6 (15.4%)	20
INR 20	3 (23%)	6 (10.5%)	1 (20%)	1 (14.3%)	0 (0%)	1 (5.5%)	8 (20.5%)	20
INR 50	4 (30%)	6 (10.5%)	1 (20%)	1 (14.3%)	0 (0%)	6 (33.3%)	2 (5.1%)	20
INR 100	2 (15%)	16 (28%)	0 (0%)	0 (0%)	0 (0%)	1 (5.5%)	1 (2.7%)	20
INR 500	2 (15%)	7 (12.2%)	0 (0%)	2 (28.5%)	0 (0%)	2 (11.1%)	7 (17.9%)	20
INR 1000	0 (0%)	8 (14%)	0 (0%)	3 (42.9%)	0 (0%)	2 (11.1%)	7 (17.9%)	20
<b>Total</b>	<b>13 (9.2%)</b>	<b>57 (40.7%)</b>	<b>5 (3.8%)</b>	<b>7 (5%)</b>	<b>1 (0.7%)</b>	<b>18 (12.9%)</b>	<b>39 (27.9%)</b>	<b>140 (100%)</b>

**Table.4** Antibiotic Sensitivity Pattern of Microbes isolated from Indian Currency Notes

	AMP		AMI		GN		CIPRO		CTZ		CFX		DOXY		CFTZ	
	S	R	S	R	S	R	S	R	S	R	S	R	S	R	S	R
<i>E.coli spp</i>	10	3	11	2	13	0	12	1	12	1	11	2	12	1	11	2
<i>Klebsiella spp</i>	40	17	49	8	52	5	55	3	45	12	46	11	55	2	44	13
<i>Pseudomonas spp</i>	2	3	3	2	4	1	5	0	5	0	4	1	4	1	3	2
<i>Micrococci spp</i>	3	4	5	2	4	3	6	1	5	2	4	3	5	2	3	4
<i>Bacillus spp</i>	11	7	6	12	10	8	15	3	18	0	12	6	15	3	12	6
<i>Staphylococcus spp</i>	0	1	0	1	0	1	1	0	0	1	0	1	1	0	0	1
<b>Total</b>	<b>66</b>	<b>35</b>	<b>74</b>	<b>27</b>	<b>84</b>	<b>17</b>	<b>93</b>	<b>8</b>	<b>85</b>	<b>16</b>	<b>77</b>	<b>24</b>	<b>92</b>	<b>9</b>	<b>73</b>	<b>28</b>

AMP- AMPICILLIN; AMI- AMIKACIN; GN-GENTAMICIN; CIPRO- CIPROFLOXACIN; CTZ- CEFTAZIDIME; CFX- CEFOTAXIME; DOXY- DOXYCYCLINE; CFTZ- CEFTRIAXONE; S- SENSITIVITY; R- RESISTANT

The frequency of occurrence of *Klebsiella pneumoniae* was the highest in the present study (40.7%) which indicates the presence of faecal contamination via cross-

contamination with raw products or poor personal hygiene. Common unhygienic practices in the open-air markets in rural areas, where traders and buyers eat market

products after handling contaminated currency notes, may place the individuals at risk of ingesting enteropathogens. [5] In contrast, isolation of *E. coli* was only 9.2% which are in accordance with the previous studies. [8, 11] The other isolates found in the present study were *Staphylococcus aureus* (0.7%) and *Pseudomonas aeruginosa* (3.8%) which is lower than the previous reports. [7, 8]

Currency notes in general were bacteriologically contaminated, especially with enteric pathogens and potentially pathogens, it was thought that some measures have to be taken to reduce these ill effects. Among the pathogenic bacteria isolated, *Escherichia coli* is a virulent organism that can cause urinary tract infections, community-acquired pneumonia, sepsis, recurrent meningitis. [12,13] *Klebsiella* spp can cause fatal acute bacterial myocarditis, pneumonia, meningitis and wound Infections. [14,15]

A number of studies have documented the clinical significance of *Staphylococcus aureus* as a causative agent of urinary tract infections. [16] Furthermore, *Staphylococcus aureus* is also associated with toxic shock syndrome, skin infections and respiratory tract infections. [17,18] These microorganisms can cause cholera, diarrhoea and urinary tract infections besides skin burn and septicaemia infections.

Money has got the potential to change through many different hands and could be exposed to many different environments at a relatively high frequency. From the results of the present investigation, it is concluded that Indian paper currency is commonly contaminated with pathogenic bacteria and this contamination may play a significant role in the transmission of different diseases. We therefore advocate a greater sensitivity

in the handling of money. The general awareness about the possibility of acquiring infection while applying saliva on fingers for counting currency notes; and practicing good personal hygiene should be created in the public. Personal hygiene to reduce risk of infection is recommended especially for those who simultaneously handle food and money.

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